Developing a Material Response Model of Biopolymer-Stabilized Regolith to Predict Micrometeoroid Damage of ISRU Habitat Systems

Completed Technology Project (2017 - 2021)

Project Introduction

The proposed space technology research aims to investigate the micrometeorite impact performance of Regolith Biocomposite (RBC), an innovative in-situ material technology that uses biopolymers to stabilize planetary or lunar regolith. This research addresses priorities described in TABS 7.1.4.10 "Application of Polymers to the Soil for Dust Passivation and/or Soil Stabilization" (currently TRL 3). RBC has been proposed as material for building stable landing pads, pavements that prevent dust levitation, and radiation and micrometeorite impact shielding for habitats. In principle, the use of this material could enable far-term capabilities by reducing mission reliance on materials and structures that would otherwise be fabricated on Earth. By testing and simulating RBC in a relevant micrometeorite environment, this research achieves the goal of advancing the technology readiness level of RBC from TRL 3 to TRL 5. This goal will be accomplished by focusing on three objectives: (1) defining the range of micrometeorite velocities relevant to proposed exploration destinations, (2) characterizing the impact performance of RBC through experimental hypervelocity impact (HVI) testing, and (3) developing a material response model of RBC using hydrodynamic code (hydrocode) computations. By testing and simulating RBC in a micrometeorite environment, this research will yield crucial insights into the durability and life expectancy of RBC as an ISRU construction material. The outcome of the proposed material response model and hydrocode will be a micrometeorite simulation tool that will allow NASA mission designers to predict damage of critical surface systems over a mission's duration, and ultimately make design decisions that reduce the risk of a catastrophic failure. This project will address NASA Roadmap TA-7 and TA-12, and help NASA achieve its goals of making space exploration more effective, sustainable, safe, and affordable.

Anticipated Benefits

The outcome of the proposed material response model and hydrocode will be a micrometeorite simulation tool that will allow NASA mission designers to predict damage of critical surface systems over a mission's duration, and ultimately make design decisions that reduce the risk of a catastrophic failure. This project will address NASA Roadmap TA-7 and TA-12, and help NASA achieve its goals of making space exploration more effective, sustainable, safe, and affordable.

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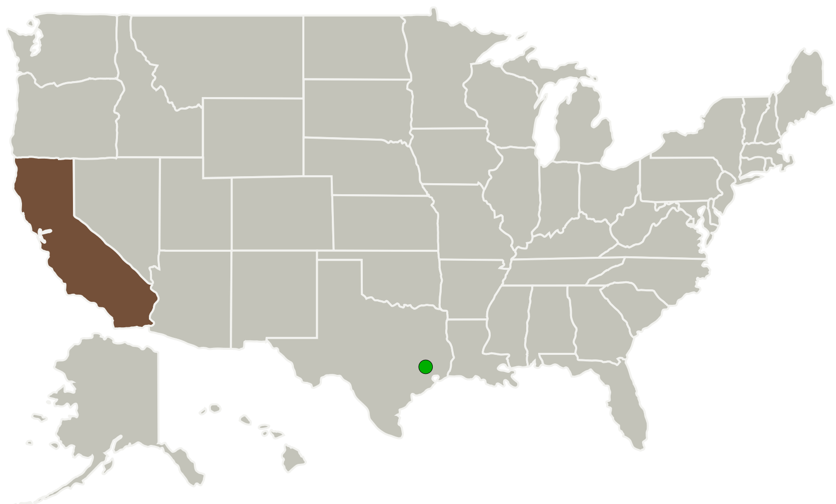
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Stanford University(Stanford)	Lead Organization	Academia	Stanford, California
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas

Primary U.S. Work Locations
California

Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Stanford University (Stanford)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

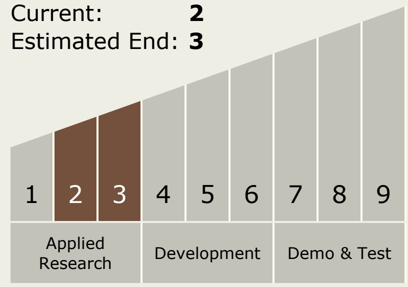
Michael D Lepech

Co-Investigator:

Maria I Allende

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  └─ TX09.4 Vehicle Systems
    └─ TX09.4.5 Modeling and Simulation for EDL

Target Destinations

The Moon, Mars, Others Inside the Solar System